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(54) **Soft contact lenses**

(57) A contact lens comprises an optical zone 1 and a peripheral zone 3, the latter having two opposite areas cut away to form a sink segment 8 and a secondary segment 11, the masses of the segments being such that the centre of gravity of the lens is displaced into the half of the lens containing the sink segment. Generally the sink segment itself is heavier than the secondary segment, especially when the segments are congruent, and is defined by a line, such as an arc 7 or chord. The lens may be of hydrophilic material. The design inhibits rotation and axis displacement during use. Other embodiments are illustrated in Figures 5-7 (not shown).

FIG. 3A.

FIG. 3B.
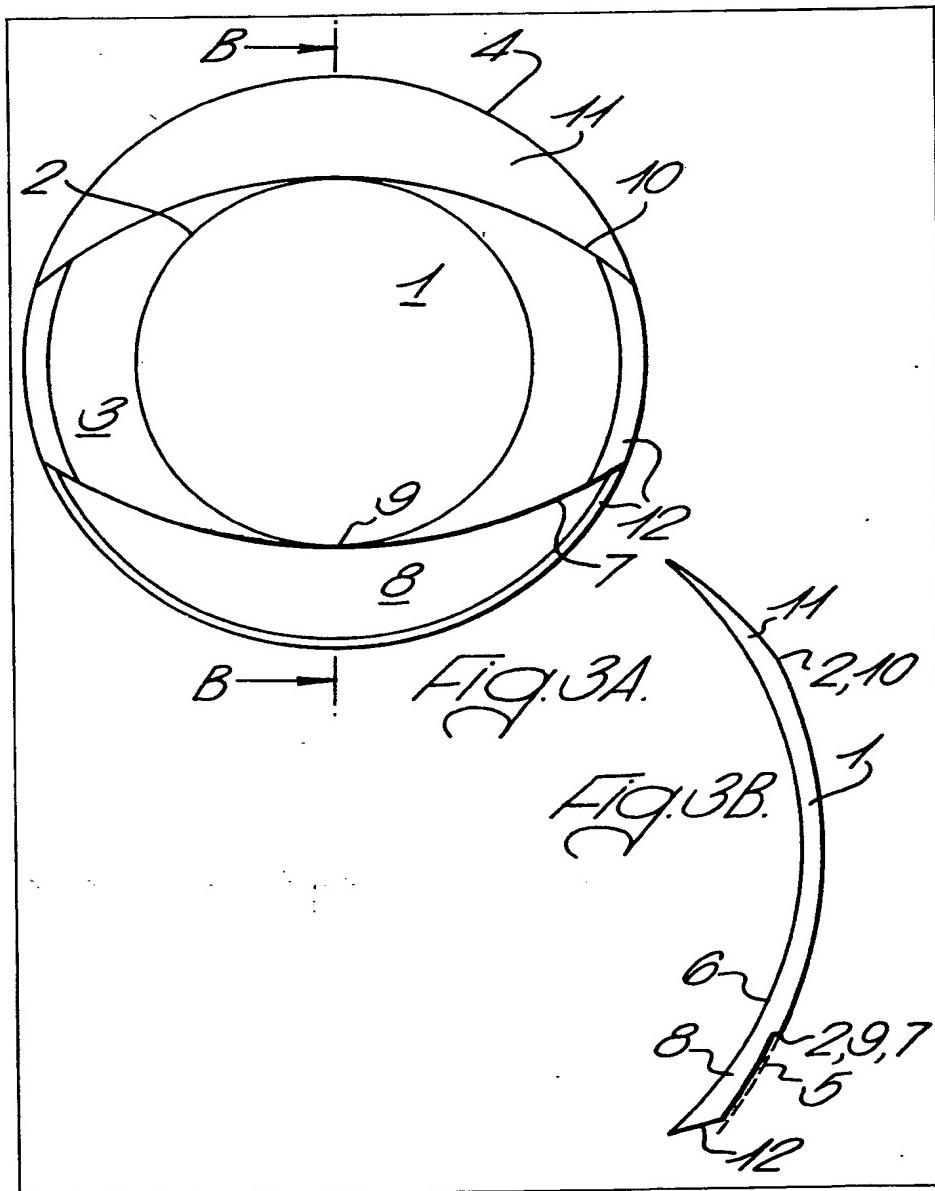
The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.
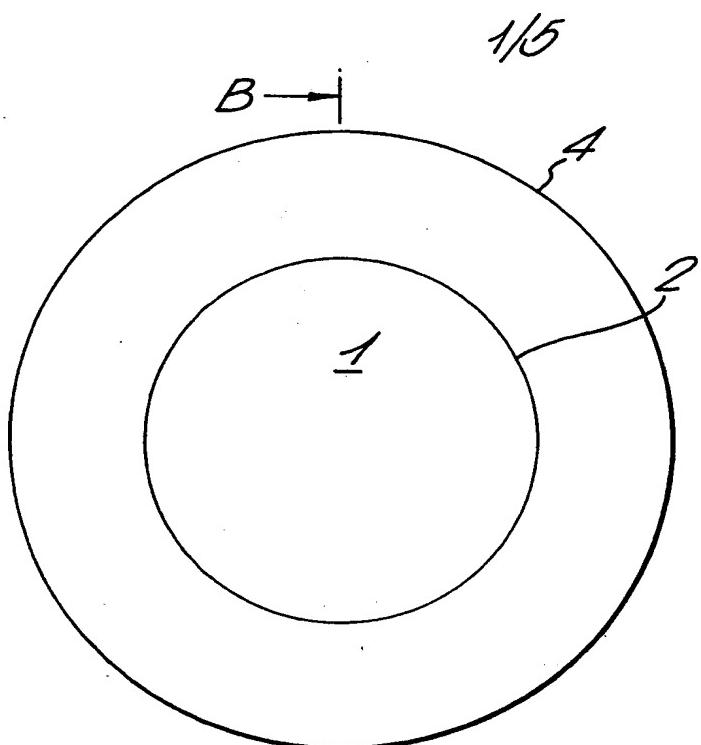
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Fig.1A.

Fig.1B.

Fig.2B.

Fig.2A.

Fig.3A.

Fig.3B.

Fig.4A.

Fig.4B.

Fig.5A.

Fig.5B.

Fig.6A.

Fig.6B.

4/5

B

4

11

10

14

15

1

2

3

9

12

8

13

12

B

Fig. 7A.

4

11

2,10

1

Fig. 7B.

6

8

2,9,13

5

12

29

L

30

29

28

27

20

26

22

21

Fig. 8.

Fig.9.

Fig.10.

Fig.11.
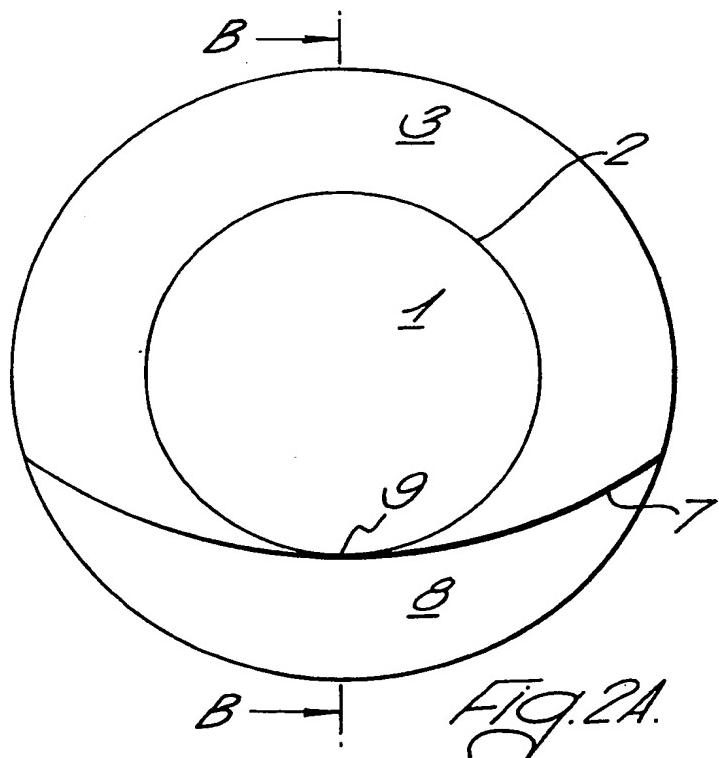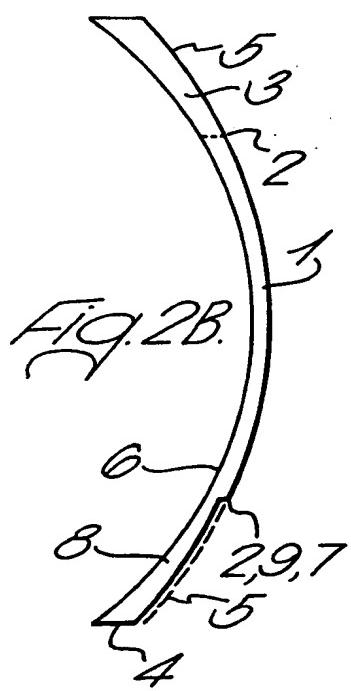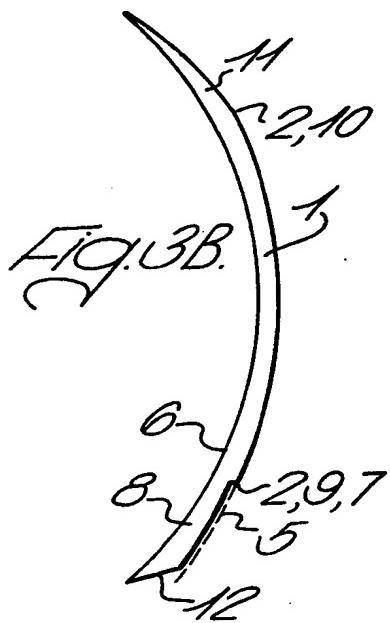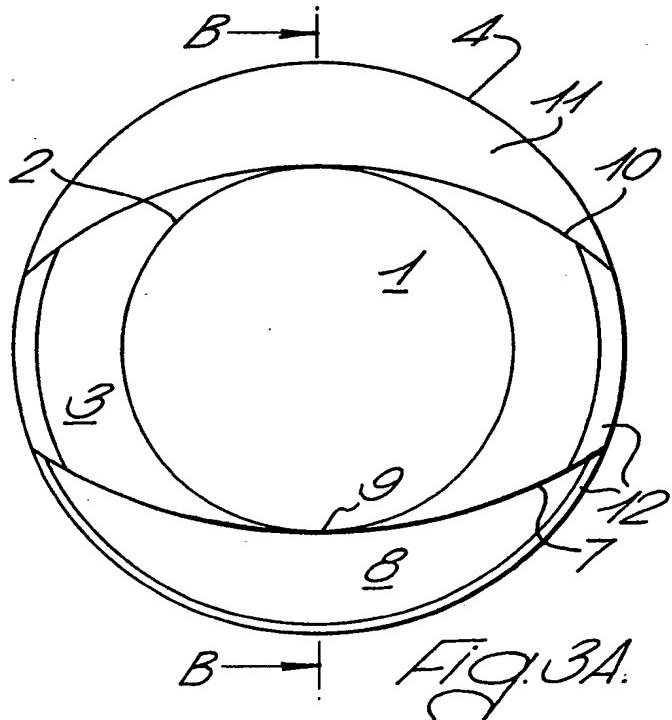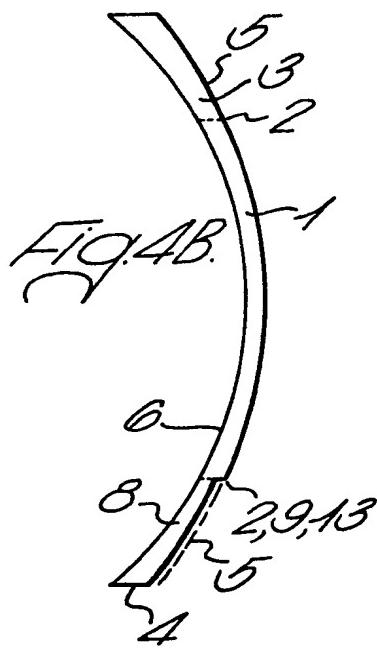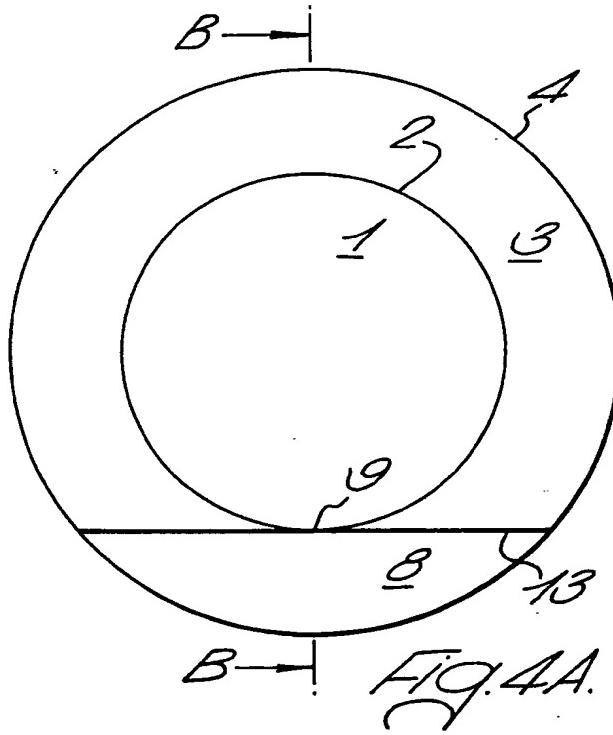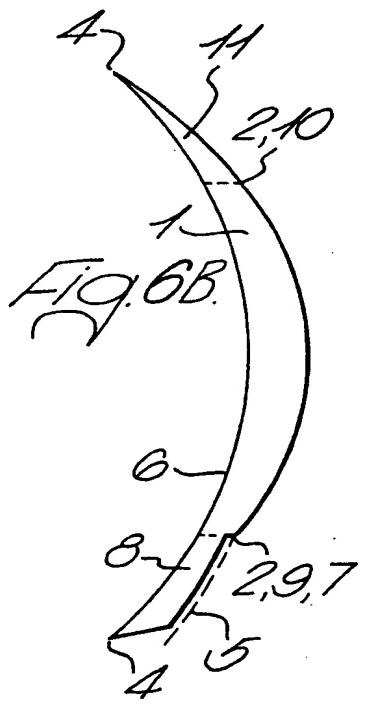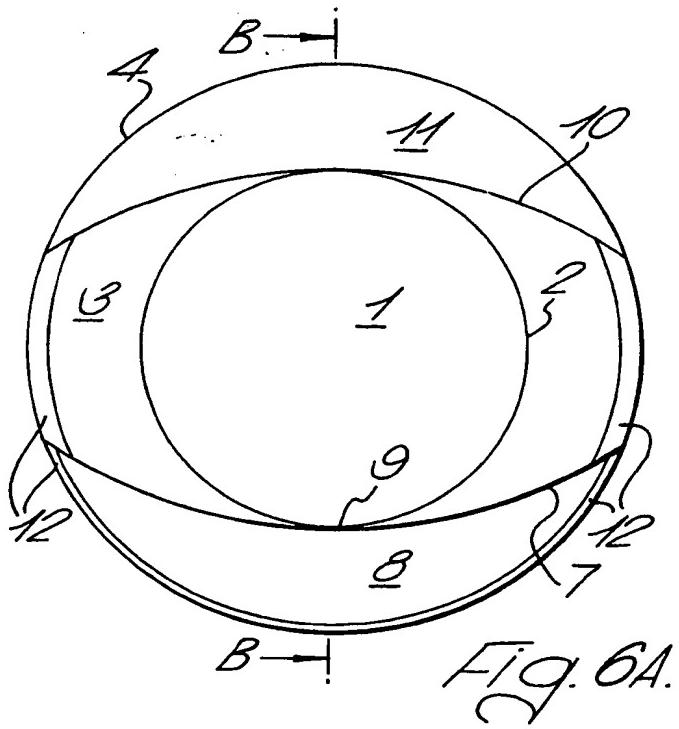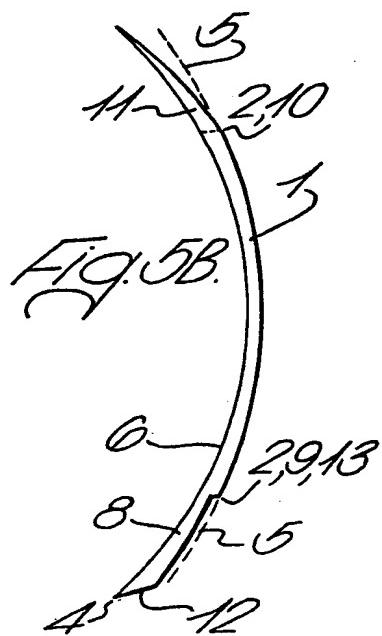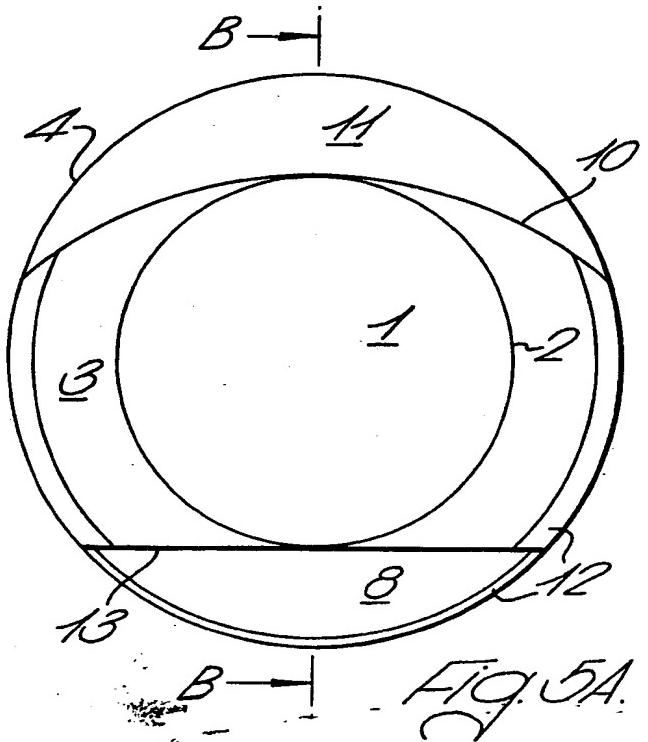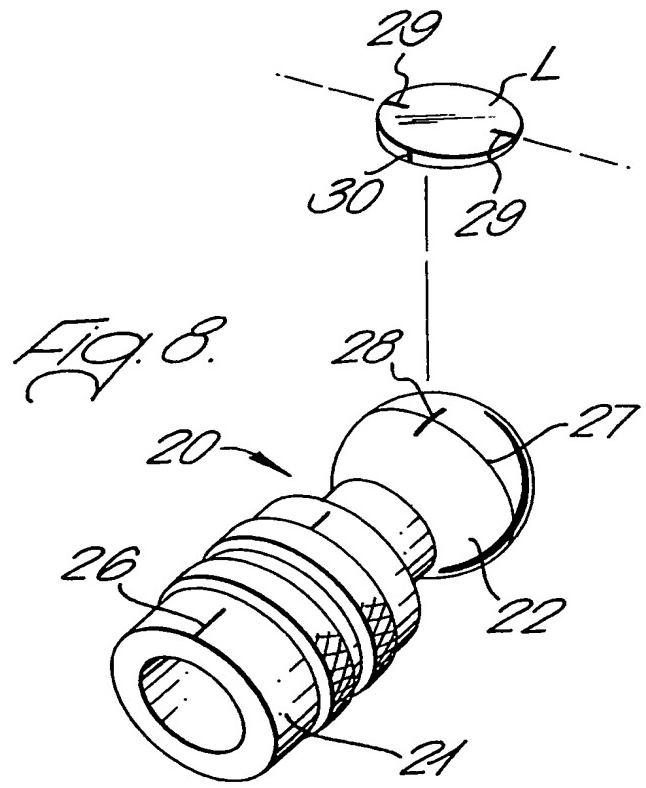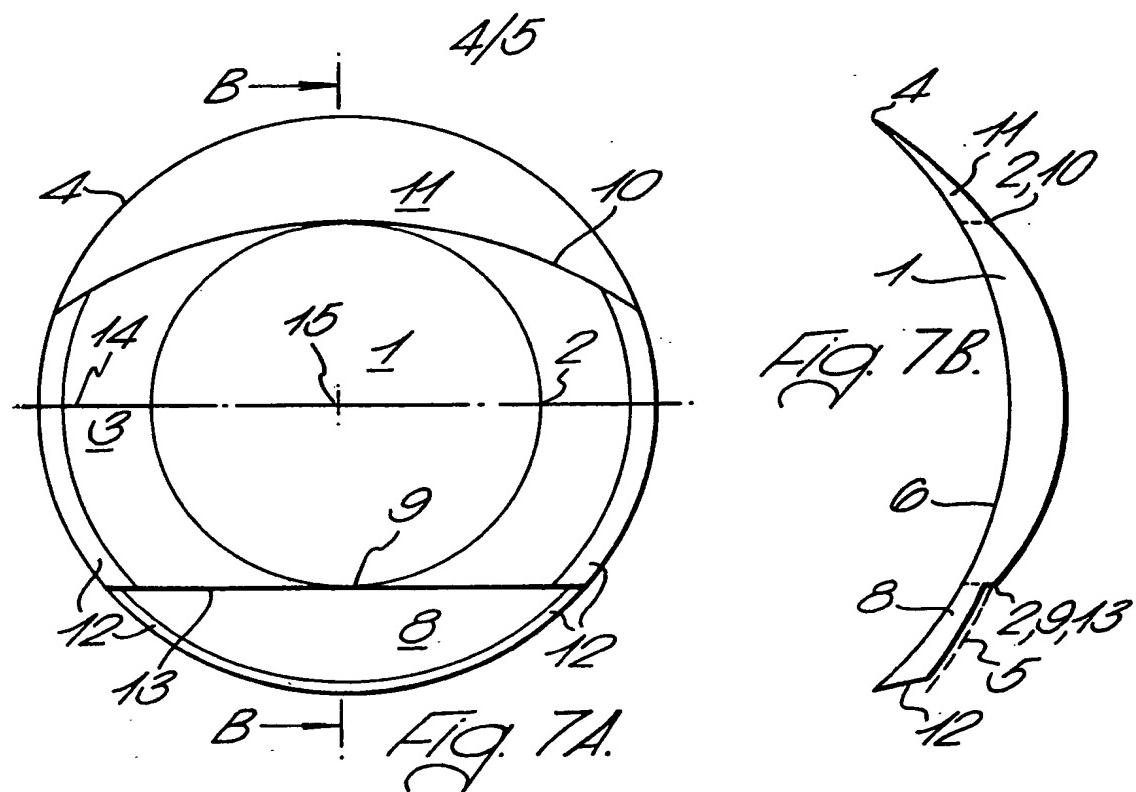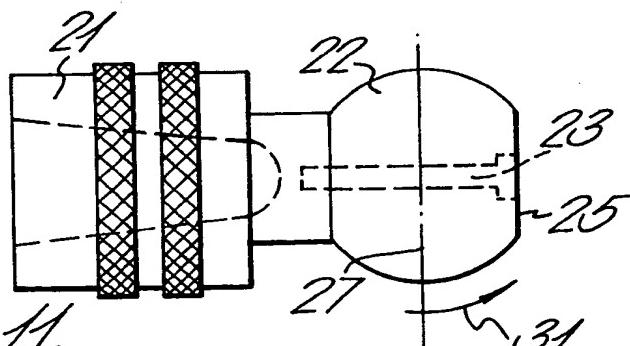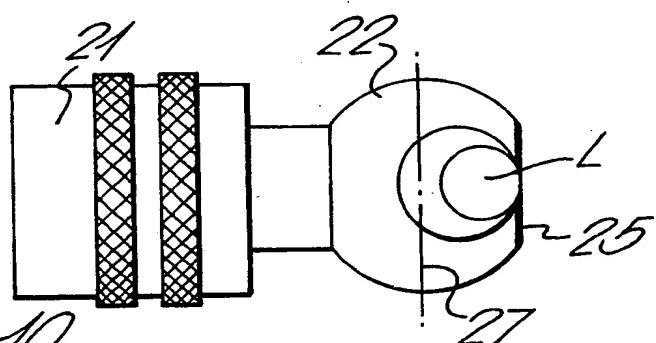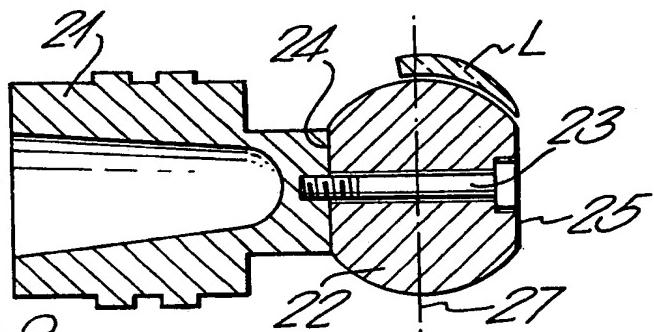
SPECIFICATION

Contact Lenses

5 *Technical field*
The present invention relates to soft contact lenses.
Background art
An outstanding difficulty encountered in wearing a
10 cylindrical soft contact lens is that it cannot be maintained in its proper axis position on the cornea of the eye-ball, owing to the normal blinking action of the wearer or patient. Every blinking action of the eye will cause a rotation of the contact lens, either
15 clockwise or anti-clockwise. Thus, the prescribed axis position of the lens cannot be maintained so as to obtain the best vision. This renders it pointless to incorporate a cylindrical correction, for patients with astigmatism, to such soft contact lenses.
20 One attempt to overcome the problem of rotation of the contact lens during use has been to employ a truncated prism base down ballast design, (see, for example, United Kingdom Patent Specification No. 1,463,107). However, this has two disadvantages:
25 Firstly, the design renders it difficult to position properly the optical centre of the lens with the visual axis of the eye and, secondly, the bottom of the lens, which is comparatively thick, creates an uncomfort-able feeling on the lower eyelid of the patient,.
30 It is also known to provide a soft contat lens with two flattened regions, each bounded by a portion of the periphery of the lens, each of which flattened regions increases in thickness in both directions from a point on the periphery and also in a direction
35 towards the centre of the lens. The flattened regions are so arranged that they are symmetrical about the centre of the lens (see United Kingdom Patent Specification 1,479,526 and DE-OS 2,415,108).
The lens is maintained in a predetermined orienta-
40 tion on the eyeball by means of eyelid movement. However, one disadvantage is that the axis of symmetry of this type of lens may not coincide with the horizontal axis. The angle of deviation (or inclination) of the 0° - 180° lens axis must therefore
45 be specially measured and included as a correction term during fitting.
Disclosure of the invention
The present invention now provides a soft contact lens comprising a central optical zone and a
50 peripheral zone, wherein the peripheral zone com-prises (a) a sink segment formed by a depression in the anterior face thereof, said sink segment being defined by a line joining two points on the circumfer-ence of the peripheral zone, and (b) a secondary
55 segment diametrically opposite the sink segment, characterised in that the mass of the secondary segment and the mass of the sink segment are such that the centre of gravity of the lens is situated in the half of the lens containing the sink segment.
60 Usually, the secondary segment will have a lower mass than the sink segment, particularly when the said segments are congruent.
Preferably, the sink segment will be defined by a chord or arc and will be formed as a depression of
65 even depth relative to the anterior face of the

peripheral zone. It is preferred that the secondary segment be defined by an arc.
In a preferred construction, the sink segment when viewed from the front will be symmetrical about an
70 axis; the secondary segment will be symmetrical about the same axis. This common axis of symmetry will be at right angles to the horizontal (0° - 180°) axis of the lens, the said axes meeting at the geometric centre of the lens. The centre of gravity will lie in the
75 half (defined by the 0° - 180° axis) containing the sink segment.
A lens according to this invention, after it has been fitted to the eyeball, will self-align with the sink segment in the lowermost position; the line defining
80 the sink segment will assume a generally horizontal position, just above the lower eyelid.
It will be seen that the contact lens of the present invention has several advantages over the prior-art lenses.
85 Thus, blinking actions will not affect the position of the lens, owing to the heavier weight of the half of the lens containing the sink segment relative to the half containing the secondary segment. Thus, the design of the lens (which may be generally characte-
90 rised as a "peripheral visible axis cylindrical soft contact lens") helps to maintain the axis of the lens and to inhibit rotation of the lens. Furthermore, in the case of unilateral cylindrical prescriptions, pris-matic jump of the image is inhibited. Moreover, the
95 present invention permits precise control of fitting; the visible line defining the sink segment serves as a reference line to the cylindrical axis, thereby giving the practitioner proof of the stability of the lens position during the fitting process and during the
100 wearing period. The secondary segment may also function as a guide for the practitioner. Also, the sink segment can interact with the lower eyelid and thereby aid in maintaining the position of the lens on the eyeball.
105 The production of the sink segment and the secondary segment can be easily incorporated into the conventional procedures for manufacturing soft contact lenses.
Thus, the present invention also provides a
110 method of manufacturing a contact lens, which comprises the steps of producing a contact lens having an optical zone and a peripheral zone; incorporating spherical and/or cylindrical correc-tions in the optical zone in accordance with the
115 prescription for the intended wearer; establishing a line joining two points of the circumference of the peripheral zone to define the sink segment and mechanically cutting, e,.g. by means of eccentricity, said sink segment in the anterior face of the
120 peripheral zone; mechanically cutting a secondary segment diametrically opposite the sink segment, usually by means of eccentricity, so that the half of the lens containing the secondary segment has a lower mass than the half containing the sink seg-
125 ment; and, optionally, forming a front-edge bevel to the lens.
Cutting by eccentricity involves placing the lens in an eccentric position to the axis of the tool carrier from which the form is being established.
130 *Brief description of drawings*

Figure 1A is a view of the anterior face of a soft contact lens representing a minus lens for the correction of short-sightedness.

Figure 1B is a vertical section along the line B-B of
5 Figure 1A.

Figure 2A is a view of the anterior face of the contact lens of Figure 1A, having a sink segment, defined by an arc, formed therein.

Figure 2B is a vertical section through the line B-B
10 in Figure 2A.

Figure 3A is a view of the anterior face of the lens of Figure 2A, having a secondary segment and front edge bevel formed therein.

Figure 3B is a vertical section along the line B-B in
15 Figure 3A.

Figure 4A is a view of the anterior face of the contact lens of Figure 1A, having a sink segment, defined by a chord, formed therein.

Figure 4B is a vertical section along the line B-B in
20 Figure 4A.

Figure 5A is a view of the anterior face of the contact lens of Figure 4A having a secondary segment and front edge bevel formed therein.

Figure 5B is a vertical section along the line B-B in
25 Figure 5A.

Figure 6A is a view of the anterior face of a contact lens representing a plus lens for the correction of farsightedness, said lens having a sink segment, defined by an arc, as well as a secondary segment
30 and front edge bevel formed therein.

Figure 6B is a vertical section along the line B-B in Figure 6A.

Figure 7A is a view of the anterior face of a contact lens similar to that of Figure 6A, but having a sink
35 segment defined by a chord.

Figure 7B is a vertical section along the line B-B in Figure 7A.

Figure 8 is a perspective view of a tool that can be employed in the manufacture of a lens according to
40 this invention.

Figure 9 is a longitudinal section through the tool of Figure 8.

Figures 10 and *11* are side views of the tool of Figure 8.

45 *Description of preferred embodiments*

The lens shown in Figure 1A may be fabricated from a hydrophilic material, as is customary for soft contact lenses. The lens will normally have a diameter of at least 12.00 mm. As shown, the lens
50 comprises two zones, an optical zone having a circular perimeter 2 and a peripheral zone 3 defined by the perimeter 2 and the outside circumference 4 of the lens. The optical zone 1 is approximately 8 mm in diameter and the peripheral zone 3 preferably has
55 a width (i.e. the radial distance between the optical-zone perimeter 2 and the circumference 4) of 2 mm to 3.5 mm.

Preferably, the outside (anterior) face 5 of the peripheral zone 3 (also known as the "lens carrier")
60 has a concavity of minus 4.00 dioptre to minus 6.00 dioptre relative to the base curvature of the inside or posterior face 6 of the lens. Accordingly, the peripheral zone is thicker at the outside edge or circumference 4 than at the optical-zone perimeter 2.
65 As shown in Figures 2A and 2B, a depression is

mechanically cut into the anterior face 5 of the peripheral zone, establishing a visible arc 7 and leaving a sink segment 8 the boundaries of which are the arc 7 and the circumference 4; as can be seen
70 from Figure 2A, the arc 7 touches the optical-zone perimeter or margin 2 substantially tangentially at a point 9.

The next stage of the manufacturing process is indicated in Figures 3A and 3B. An area of the face 5
75 of the peripheral zone directly opposite the sink segment 8 is mechanically cut away by eccentricity, establishing a secondary arc 10 which defines, with the circumference 4, a secondary segment 11 of reduced weight and thickness; in particular, the
80 mass of the secondary segment 11 is less than the mass of the sink segment.

Finally, a front edge bevel may be formed near the circumference 4 of the anterior face 5 of the peripheral zone 3. The bevel 12 reduces the edge
85 thickness of the lens, thereby increasing the comfort whilst it is being worn.

As can be seen in Figure 3A, the areas of the sink segment and secondary segment are congruent.

It should be noted here that, in order to avoid
90 unnecessary repetition in the discussion of the remaining drawings, like parts are indicated by like numerals.

The lens shown in Figures 5A and 5B is similar to that shown in Figures 3A and 3B except that the sink
95 segment 8 is defined not by an arc but by a visible chord 13. In this lens, the sink segment 8 and the secondary segment 11 are not congruent, since the later is defined still by a secondary arc.

The secondary segment is, in general, formed by a
100 secondary arc (rather than a secondary chord) because (a) it is easier to manufacture mechanically and technically and (b) it reduces the friction of the upper eyelid with the margin of the lens (the segment margin). A straight-line margin would
105 cause the edges of the perimeter, where the segment is cut, to be pointed and therefore would cause greater irritation. The lower eyelid is stable and therefore a chord would not cause the same sort of irritation.

110 Figures 4A and 4B represent a stage in the manufacture of the lens of Figure 5A and Figure 5B, wherein only the sink segment 8 has been formed.

The finished contact lens shown in Figures 6A and 6B is similar to that shown in Figures 3A and 3B,
115 except that the optical zone 1 has a different correction.

The finished lens shown in Figures 7A and 7B is similar to that shown in Figures 5A and 5B, except that the optical zone 1 has a different correction.
120 In Figures 3A, 5A, 6A and 7A, the line B-B indicates the axis of symmetry of each segment 8 and 11, as viewed from the front. An axis 14 passing through the geometric centre 15 of the lens and at right-angles to the axis B-B can be postulated. (The axis 14
125 and centre 15 are indicated only in Figure 7A, for simplicity). In accordance with this invention, the centre of gravity of the lens lies below the line 14, i.e. in the half containing the sink segment 8.

Of course, variations from the illustrated embodi-
130 ments are possible. For example, the chord or arc

defining the sink segment need not meet the perimeter or the margin of the optical zone at a tangent. It may vary from prescription to prescription.

Similarly, although the sink segment and the
5 secondary segment are congruent in the lens of Figure 3A and the lens of Figure 6A, this need not always be the case; again it may vary from prescription to prescription.

Turning now to Figures 8 - 11, the illustrated tool
10 20 comprises a body portion 21 to which a head portion 22 is affixed, as by a screw 23. The head portion 22 is in the form of a sphere truncated by two opposed flat surfaces 24, 25.

The body portion 21 is provided with a line 26
15 indicating the longitudinal axis of the tool. The equator of the head portion is indicated by line 27 and the crossing point of the axis line 26 and the equator line 27 is indicated by a mark 28.

A soft contact lens L is placed on the head portion,
20 as indicated in Figures 9 and 10, in readiness for cutting. (The lens L shown in Figure 10 is a bifocal contact lens.) Prior to cutting, the lens L is provided with marks 29 that indicate the toricity axis and with a mark 30 that indicates the position where the sink
25 segment is to be incorporated.

The lens L is first placed on the head portion 22 so that the axis of the lens lies on the axis of the tool. The position of the lens is then adjusted as required. The diameter cutter (not shown) is positioned at the
30 lower-most point of the lens edge. The cutter runs at loci to the tool whilst the tool rotates. A chord is cut on the part of the lens below the equator 27 whereas an arc is cut on the part of the lens above the equator. The direction of the cutter is indicated by
35 the arrow 31 in Figure 11.

The soft lens of this invention may be made of any appropriate material. For example, as an alternative to a hydrophilic material, a suitable silicone rubber could be used; in this case, however, a moulding
40 technique might be used in the lens manufacture.

It may be added, at this point, that the expression "soft contact lens" also includes a hydrophilic lens in a dehydrated state.

In the case of a lens with a mild prescription, it
45 may be necessary to provide additional prismatic ballast to stabilise the position of the lens, as thinner lenses would require greater mass.

In preferred embodiments above, the sink segment is formed by a depression of even depth cut in
50 the anterior face. However, it is also possible to form the sink segment itself with an even thickness. Furthermore, the sink segment may vary in thickness; thus, it could increase smoothly from a point on the circumference in both directions around the
55 circumference and in the direction towards the centre of the lens.

CLAIMS

60 1. A soft contact lens comprising a central optical zone and a peripheral zone, wherein the peripheral zone comprises (a) a sink segment formed by a depression in the anterior face thereof, said sink segment being defined by a line joining two points
65 on the circumference of the peripheral zone, and (b) a secondary segment diametrically opposite the sink segment, characterised in that the mass of the secondary segment and the mass of the sink segment are such that the centre of gravity of the lens is
70 situated in the half of the lens containing the sink segment.

2. A contact lens according to claim 1, characterised in that the sink segment is formed as a depression of even depth relative to the anterior face
75 of the peripheral zone.

3. A contact lens according to claim 1 or 2, characterised in that the line defining the sink segment is a chord or arc.

4. A contact lens according to claim 1, 2 or 3
80 characterised in that the secondary segment is defined by an arc.

5. A contact lens according to any of claims 1 to 4, characterised in that the secondary segment has a lower mass than the sink segment.

85 6. A contact lens according to any of claims 1 to 5, characterised in that the peripheral zone is provided with a front-edge bevel.

7. A contact lens according to any of claims 1 to 6, characterised in that the anterior face of the
90 peripheral zone has a basic concavity of -4.00 dioptre to -6.00 dioptre relative to the posterior face of the lens.

8. A contact lens substantially as herein described and as illustrated in Figures 3A and 3B, in
95 Figures 5A and 5B, in Figures 6A and 6B, or in Figures 7A and 7B.

9. A method of manufacturing a contact lens according to any of claims 1 to 8 which comprises the steps of providing a contact lens having an
100 optical zone and a peripheral zone; incorporating spherical and/or cylindrical corrections in the optical zone, establishing a line joining two points on the circumference of the peripheral zone to define the sink segment in the anterior face of the peripheral
105 zone; mechanically cutting said sink segment in the anterior face of the peripheral zone; mechanically cutting a secondary segment diametrically opposite the sink segment so that the half of the lens containing the secondary segment has a lower mass
110 than the half containing the sink segment; and, optionally, forming a front edge bevel.

10. A method according to claim 9, characterised in that the sink segment and/or the secondary segment is/are formed by eccentricity.

115 11. A method according to claim 9, substantially as hereinbefore described and as illustrated in Figures 8 to 11.